IP Primer

Everything you need to know

Part 1: Introduction

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Over eight parts Calrec's AoIP Network Primer provides a comprehensive overview of the technologies involved in implementing AoIP workflows.

One does not need to read this guide from front to back to implement AoIP networks. AoIP networks can consist of a few switches and a few AoIP devices.

Network configuration can be done using factory defaults or prebuilt configurations available from various sources.

On the other hand, AoIP networks can be extraordinarily complex ecosystems specifically designed to meet the demanding workflows, resilience, and elastic requirements of a broadcaster.

This guide details the underlying technologies that are required to implement AoIP in its simplest and most complex forms.

Some prior knowledge is assumed and networking fundamentals are not covered in this guide. We have however created a series of webinars for this exact purpose which can be found on our website:

https://calrec.com/calrec-sound-institute/

What is a network?

A network is a collection of interconnected nodes organised to move information efficiently.

More and more, everything we interact with is attached to some kind of network, from phones and computers to fridges and lamps. The Internet of Things is a term often used to explain this concept, where physical objects are connected to the internet to communicate information with other physical objects all over the world.

Networks support the way we live, how we talk to each other, how we automate our lives and how we consume content. We shop online, we study online, we order food online. We are surrounded by networks.

We are defined by them.

Simply put, a network is a tool that allows the exchange of data between devices.

In the case of AoIP, the data in on a network is audio and the devices are mixing desks, loudspeakers, microphone preamps etc. A well designed network should be invisible to the end-user; all the user needs to care about is audio production.

Therefore, it's important to pay attention to the network requirements. Different broadcasters have different workflows and requirements; the good news is that IP technologies are so flexible that they can be adapted to meet these needs exactly.

It also means that there is never one single standard network infrastructure which will meet all requirements, so networks have to be carefully designed from the outset.

This Primer is designed to help you to create AoIP setworks which enable your desired workflow without defining or compromising operations.

Each week we will make a new chapter available – this week is an introduction to IP technologies and standards, and we'll look at some of the terms you need to know.

In future chapters we'll look at Multicast, the Precision Time Protocol (PTP), Bandwidth, Latency/Jitter, QoS, Switches and we will end with a detailed look at the benefits of good Network Design. This last chapter pulls in elements of all the previous chapters and includes advice on best practice and explanations on how differing infrastructure setups can affect your workflows.

For more like this, sign up to our Soundwaves Newsletter at https://calrec.com/sign-up/

Introduction

This AoIP network guide offers a comprehensive overview of the technologies involved in implementing AoIP.

What is a network?

Fundamentally, a network is a tool that allows the exchange of data between devices. In the case of AoIP, the data is audio, and the devices are mixing desks, loudspeakers, microphone preamps etc. The network should be invisible to the end-user; for all the user needs to be concerned about is audio production.

The network should enable the workflow requirements of the broadcaster. Due to the variable nature of different broadcaster workflows, this often means that there is not a one size fits all network solution. Thankfully, IP technologies are flexible and can be adapted to many different workflows and use cases. AoIP Networks can enable your desired workflow without defining it.

Practically, networks are made up of network devices such as switches, routers, firewalls and others. In broadcast, layer 2 and layer 3 switches are the most common due to their scalability and performance characteristics.

The methods of passing data through a network vary between layer 2 and layer 3 technologies, and each has its pros and cons. This guide goes into these technologies in detail.

Benefits of AoIP Networking

The huge rise in demand for content and evolving consumption methods have fuelled demand for flexible and scalable infrastructures. IP infrastructures contain all the necessary characteristics needed to aid content creation in an environment where production requirements are often demanding, scalable and variable.

AoIP facilitates flexible workflows and provide opportunities for content creation that were not previously available, whilst also maintaining broadcaster's legacy workflows. It allows interoperable resource sharing that can increase agility and collaboration. It provides an infrastructure that can be used for both file based and live to air workflows.

AoIP networking is future proofed too; IP networks can scale upwards to supply higher levels of throughput to account for:

- Future production requirements
- Higher bandwidths required by the next generation of audio and video formats and standards.

Facilities that are IP native also have the added benefit of simplified interfacing with other facilities, whether they be studios, OB vans, remote locations or cloud environments.

Standards

For AoIP to be interoperable, the rules of transmission, discovery and connection must be standardised. This effectively means that all AoIP products speak the same language for all their operational interactions.

This section outlines the main standards that allow for efficient and interoperable AoIP.

AES67

AES67 defines the format for the transport of audio over IP using a collection of existing, proven and open protocols. The goal of AES67 is to provide the interoperable exchange of audio between different product vendors.

Amongst other things, AES67 defines audio format (sample rate, bit depth), packet format, clock usage, QoS markings, buffering requirements and addressing. Protocols referenced in AES67 include IP, UDP, RTP, SDP, IGMP, PTPv2.

AES67 mentions several options for device discovery but does not mandate any particular technology.

SMPTE ST2110

SMPTE's 2110 defines "elemental streaming". The elemental streaming methodology uses separate RTP streams for video, audio and metadata, making audio/metadata payload more accessible and independently route-able, while the RTP protocol takes care of time-alignment of the different streams. SMPTE ST2110 is popular within the broadcast industry because of inclusiveness of video, audio and data.

ST2110-30

ST2110-30 is the audio specific ST2110 standard. For the most part, ST2110-30 references AES67 for media transport, but adds more specific audio and packet formats that would grant an AoIP device different levels of compliance.

ST2022-7

Network redundancy is not mandatory under either AES67 or ST2110, but ST2110 does say that if redundancy is provided, then it should conform to ST2022-7.

Under ST2022-7, a media stream is duplicated, allowing receiving devices to take data on a packet-by-packet basis from multiple streams. Typically, there are two streams used for each media flow (although 2022-7 itself is not limited to two); devices output media over their "first" connection and duplicate that media over streams on their "second" connection.

There are several nomenclatures in circulation for names of the "first" and "secondary" networks including: primary/secondary, A/B, Red/Blue, Amber/Blue. In this guide we will refer to independent ST2022-7 networks as Amber/Blue as to be consistent with the JT-NMs TR1001-1.

Both Amber and Blue connections can pass over the same network hardware (and some devices even support ST2022-7 redundant streams over a single physical NIC interface), but for best redundancy, including against network failure, physically separate networks are often deployed.

A receiving device is free to take the media from either the Amber or Blue stream, seamlessly on a packet-by-packet basis, which protects against packets being dropped or becoming corrupt as they traverse the network.

PTP

Precision Timing Protocol, specifically version 2 (with a formal name of IEEE-1588-2008), is a method of synchronising clocks across a network with sub microsecond accuracy.

PTP is an extremely important protocol for AoIP. Without it, exchange of audio is not possible. As AoIP networks scale, it is important to understand your PTP configuration and to ensure the network and AoIP devices are correctly configured for PTP.

ST2059-1

ST2059-1 describes the clock generation capabilities of an end device based on timing information contained within PTP messaging.

ST2059-2

ST2059-2 defines a standard set of PTP parameter sets to be supported on end devices. The ST2059-2 has been specified specifically for media applications.

AMWA NMOS IS04 & IS05

NMOS provides a centralised server approach allowing AoIP devices from different manufacturers to be managed in the same way, reducing the reliance on the individual and varied web-UIs that each device may serve.

IS-04 provides a discovery and advertisement mechanism for end devices to pass their stream configuration information to a central server.

IS-05 provides connection management, allowing users to interact with a single application that can present and allow management of connectivity in a familiar way that fits with broadcast workflows.

TR1001-1

TR1001-1 is a technical recommendation rather than a standard, produced by the JT-NM.

TR1001-1 offers a framework for an interoperable AoIP facility making recommendations on network configuration, device discovery and connection management. TR1001-1 references the standards above but goes beyond by recommending technologies to enable simplified operations to broadcasters.

Calrec

Calrec is committed to the standardisation of AoIP and Networking tools that enable its customers to meet their AoIP deployments regardless of scale or complexity.

All Calrec AoIP implementations are compliant to:

- AES67
- ST2110-30
- ST2022-7
- ST2059-1
- ST2059-2
- PTPv2
- NMOS IS-04
- NMOS IS-05

Summary

In this guide, all topics are covered to enable a user to understand and design AoIP networks that help broadcasters achieve their unique workflow goals.

The following page lists terminology which is commonly used when talking about AoIP networks.

Terminology used in this Primer

ACL – Access Control List
BMCA – Best Master Clock Algorithm
bps – bits per second
CLI – Command Line Interface
COTS – Commercial off te Shelf
DHCP – Dynamic Host Configuration Protocol
DNS – Domain Name System
DNS-SD – Domain Name System – Service Discovery
DSCP – Differentiated services code point
Gbps – Gigabits per second
GMC – Grand Master Clock
GUI – Graphical User Interface
IB – In band
IGMP – Internet group membership protocol
IP – Internet Protocol
MAC – Media Access Control
Mbps – Megabits per second
mDNS – Multicast Domain Name System
Mpps – Millions of packets per second
MTU – Maximum transmission unit
NAT – Network Address Translation
NIC – Network Interface Card
OB – Outside Broadcast
OOB – Out of Band
OUI – Organizationally unique identifier
PDV – Packet delay variation
PIM – Protocol Independent Multicast
PTP – Precision Time Protocol
QoE – Quality of Experience
QoS – Quality of Service
RP – Rendezvous Point
RPF – Reverse Path Forward
RTP – Real-time transport protocol
SDN – Software defined networking
SPF – Shortest Path First
SSM – Source specific Multicast
SNMP – Simple Network Messaging Protocol
Tbps – Terabit per second
TCP – Transmission Control Protocol
UDP – User Datagram Protocol
UI – User Interface
VPN – Virtual Private Network
VRF – Virtual Routing and Forwarding

Coming up next...

Part 2: Multicast

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